

PETROLOGIC COMPARISON OF HIGH- AND LOW-TITANIUM BASALT CLASTS DERIVED FROM ANGSA CORE 73001. Z. E. Wilbur¹, A. Tatch¹, J. J. Barnes¹, S. A. Eckley², T. Erickson², M. Brounce³, C. A. Crow⁴, J. W. Boyce⁵, J. L. Mosenfelder⁶, A. C. Stadermann⁵, J. Gross⁵, and the ANGSA Science Team⁷. ¹Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, 85721, USA (zewilbur@email.arizona.edu); ²Jacobs- JETS II, NASA Johnson Space Center, Houston, TX, 77058, USA; ³University of California, Riverside, CA, 92521, USA; ⁴University of Colorado, Boulder, CO, 80309, USA; ⁵NASA Johnson Space Center, Houston, TX, 77058, USA; ⁶University of Minnesota Minneapolis, MN, 55455, USA; ⁷List of co-authors includes all members of the ANGSA Science Team (<https://www.lpi.usra.edu/ANGSA/teams/>).

Introduction: Volatile elements and compounds significantly influence the properties and behavior of magma, including ascent and eruptive processes [e.g., 1]. Basalts record a complicated history of the volatile species inherent to their parental magma, and the processes, such as degassing, that change these volatile inventories [e.g., 2, 3]. On the Moon, outstanding questions remain concerning the behavior of magmatic volatiles and their roles in the evolution of lunar magmas and the formation of mare basalts.

As part of the Apollo Next Generation Sample Analysis (ANGSA) program, we are investigating the petrogenesis of two basalt clasts collected from the recently processed Apollo 17 drive tube, 73001. Our team is studying the petrology of the two basalt clasts in 2D and 3D. Recent work has highlighted the utility of coupling traditional 2D methods with 3D measurements to better understand the crystallization and degassing histories of lunar lava flows [3]. We are also investigating the volatile inventory of the samples through in situ studies of volatile-bearing phases, like apatite, to understand the eruptive signatures and degassing histories of low-titanium and high-titanium lunar basalts [e.g., 2, 3].

At the upcoming conference, we will present the first detailed study of the 2D and 3D mineralogy, textures, 3D vesiculation, and chemistry of these basalt clasts to shed light on their magmatic, volcanic, and post-eruptive histories.

Samples: The two clasts examined in this study were extracted from the recently processed 73001 core (**Fig. 1a**). Both clasts derive from pass 2 (**Fig. 1b**). The high-Ti basalt (mass of 0.785 g) is from interval 25 (**Fig. 1c,d**), was denoted 73001,1095B for X-ray computed tomography (XCT) scanning, and was cut and polished to a thick section denoted 73001,531. The low-Ti basalt (mass of 0.123 g) is from interval 62, was denoted 73001,1234B for XCT scanning, and was cut and polished to a thick section denoted 73001,538.

Methodology: Polished thick sections were surveyed using a Keyence VHX 7000 Digital Optical Microscope in the Lunar and Planetary Laboratory (LPL) at the University of Arizona. X-ray elemental and

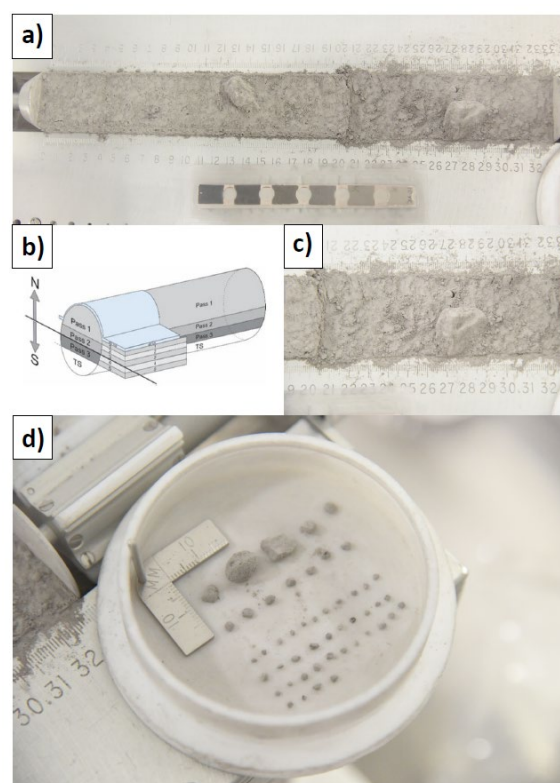


Figure 1. *a) Photograph of 73001 during dissection. b) Schematic of 73001 denoting the locations of each pass, where TS: thin section [image from 5]. c) Interval 25 from which 73001,1095B was collected. d) The particles collected from interval 25. 73001,1095B is a clast within the 4-10 mm size fraction. Photo Credit: NASA Johnson Space Center (JSC) curation.*

backscattered electron (BSE) mapping of polished thick sections of 73001,531 and 73001,538 were performed using the JEOL 7900F scanning electron microscope (SEM) in the Astromaterials Research and Exploration Science (ARES) at NASA's Johnson Space Center (JSC). The chemistry of major (e.g., pyroxene and feldspar) minerals and accessory phases (e.g., apatite) within these samples was determined using the CAMECA SX100 electron microprobe analyzer at the University of Arizona's Kuiper-Arizona Laboratory for Astromaterials Analysis (K-ALFAA) at the LPL. Modal mineralogy in 2D was determined from the X-ray maps

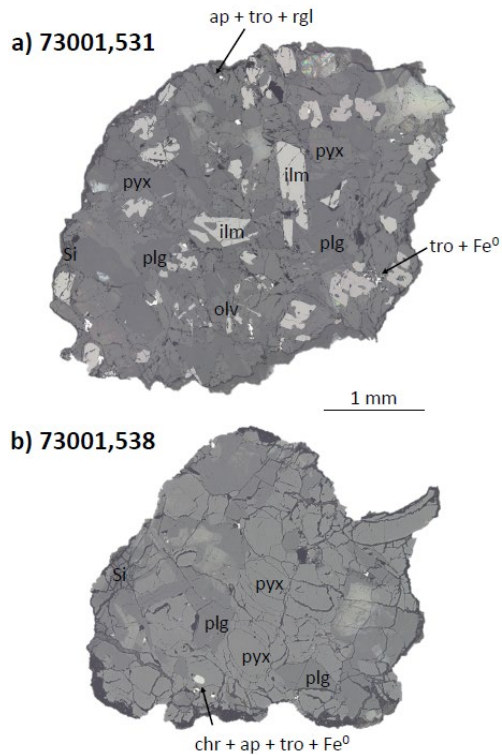


Figure 2. Reflected light mosaics of the studied clasts in thick section. **a)** high-Ti basalt 73001,531. **b)** low-Ti basalt 73001,538. Phases labeled as plg: plagioclase, pyx: pyroxene, olv: olivine, ilm: ilmenite, rgl: residual glass, ap: apatite, Si: silica, tro: troilite, chr: chromite and Fe⁰: metal.

using *ImageJ* software. For 3D study, bulk subsamples of 73001,1095B and 73001,1234B were scanned using XCT with the Nikon XTH 320 instrument at JSC to determine 3D mineralogy, fabrics, and vesiculation textures. The samples were scanned with a 180 kV transmission source without a filter using the following conditions: 90 kV, 33 μ A, and a voxel size range of 4.07 μ m for 73001,1234B and 6.71 μ m for 73001,1095B. These scans have been reconstructed using CT Agent Pro and visualized using Dragonfly™ software. Vesicles were separated and measured with Blob3D [6], and vesicle fabrics were quantified using *Stereonet 11* [8] following the methods of [3].

2D Petrographic Results: Section 73001,531 (high-Ti) is a poikilitic basalt consisting of plagioclase (41.1 vol.%) enclosing pyroxene (43.0 vol.%). Ilmenite (13.8 vol.%) contains inclusions of plagioclase and pyroxene (Fig. 2a). The minor and trace phases present include olivine (0.8% vol.), phosphates (<0.1 vol.%) within mesostasis regions, cracked silica (0.3 vol.%), Si-rich glass (0.1 vol.%) found as inclusions in ilmenite and

within mesostasis regions, and sulfides with rounded inclusions of Fe metal (0.9 vol.%).

Section 73001,538 (low-Ti) primarily consists of irregular, rounded olivine enclosed by zoned pyroxene (57.3 vol.% pyroxene + olivine; **Fig. 2b**). The pyroxene has Mg-rich cores (18.8 vol.%) and Fe-rich rims (37.9 vol.%). Plagioclase grains (39.4 vol.%) are anhedral and elongated. Phosphates (<0.1 vol.%) are found near or as inclusions within pyroxene. Silica (2.7 vol.%) is more abundant than in 73001,531 and is elongated with a fish-scale texture. Some sulfide grains in 73001,538 contain rounded Fe metal inclusions (0.3 vol.% sulfide + metal), although more commonly Fe metal is observed as discrete grains. Ilmenite and chromite (0.2 vol.% oxides) are present with ovoid, rounded shapes.

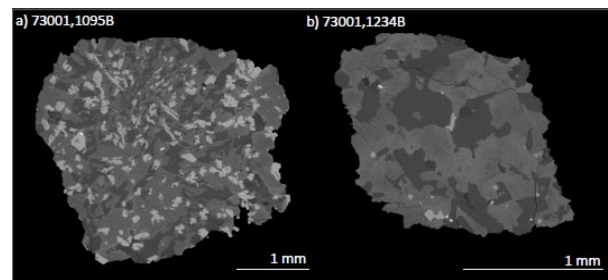


Figure 3. Representative XCT slices for **a)** 73001,1095B and **b)** 73001,1234B. Denser phases (i.e., ilmenite, metal, sulfide) appear brighter than less dense minerals (i.e., plagioclase and pyroxene).

Discussion: The 2D modal mineralogy measured for the two ANGSA clasts aligns with ranges reported for high-Ti Apollo 17 and low-Ti Apollo 15 basalts [e.g., 3, 9]. Our XCT studies of the clasts (**Fig. 3a,b**) show differences in textures compared to the 2D sections (**Fig. 2a,b**). We observe more abundant, lath-like ilmenite in 3D (**Fig. 3a**) within 73001,1095B compared to its 2D thick section (**Fig. 2a**). These ilmenite discrepancies align with previous findings by [3]. At the meeting, we will present our mineral chemistry and 3D modal mineralogy and vesiculation fabric results to better constrain the crystallization and degassing histories of low- and high-Ti lunar basalts.

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